MUSINT: a virtual habitat for relocated archaeological artifacts

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Abstract: The purpose of this contribution is to present an educational and interactive tool to be accessed on-line to share knowledge about Aegean archaeological collections held by various museums in Tuscany, Italy, and reconnect them to the geographical sites they come from, recovering also the historical, cultural and technical information to understand better the importance of the artifacts which suffer of limited visibility where they are now kept. The paper is tailored to show how the described structure and exploration modalities of MUSINT's virtual museum meet these expectations, addressing one of the subject fields offered by the displayed contents: the Cretan collection in Florence, and particularly, within the collection, they clay finds from the Messara region, where the excavations of the renowned sites of Haghia Triada and Phaistos were carried out by the Italian Mission in Crete from the beginning of the 20th century. The documentation made available to the visitor in the system includes texts, adapted also for younger users, old and new photos, maps and plans of the sites, 3D models of the artifacts based on their metric survey, hypothetical reconstructions, drawings and cartoons, providing an incisive integration which recreates the historical context of each find and offers in-depth examination on demand.

Keywords: archaeological collections, Crete, virtual museum, 3D models.

Introduction

This paper illustrates just a section of the contents of a broader project, titled MUSINT, currently dedicated to *The virtual museum of the Aegean and Cypriot collections in Tuscany*, soon available on the Web[9], and synthesizes its implementation. The project aims to connect regional archaeological collections and share knowledge about medium and small size artifacts stored in far apart museums and not usually accessible to visitors, in spite of their distinguished value in terms of quality and variety of the repertoire. But this is only the primary purpose of MUSINT. It seems, in fact, particularly relevant to create also a further connection between the objects exhibited today in a museum and the place where they were originally located – obviously, in case provenance is known – guiding MUSINT's visitor along an itinerary to discover the object's historical and geographical initial context, an itinerary which starts from the last relocation, unrelated to the object's nature. This is precisely the subject matter of our contribution, which aims to explicate one of the possible applications of MUSINT.

[9] The virtual museum of the MUSINT project, sponsored by the Region of Tuscany, will be soon available on-line, within a dedicated web portal. A volume (JASINK et al. 2011) has been published to support the project: it's focused not only on its description and realization, but also on further conceivable implementations suggested by the project.

The specific field of study we have presented during this Conference is limited to the Cretan collection in Florence, and, within the collection, to clay finds from the Messara region. Consequently, on one side we illustrate some aspects of the southern area of Crete where two of the most important sites of the Minoan civilization flourished: Haghia Triada, with its *villa* dominating over the lower town and an annexed necropolis extending at its feet, and Phaistos with its palace at the center. On the other side, we take into consideration the Archaeological National Museum of Florence, which holds some of the artifacts found in the two mentioned sites, due to the fact that the excavations of Haghia Triada and Phaistos were carried out by the Italian Mission in Crete, started at the beginning of the 20th century, and a number of such objects were given as a token gift to the Florentine Museum.

Fig. 1 – The *villa* of Haghia Triada after the excavations (Photographic material from SAIA – Italian Archaeological School in Athens, kindly offered by the Director, Prof. E. Greco).

The sites

Our contribution is focused on a limited time span of the two archaeological sites of Haghia Triada and Phaistos. As for the first, we will be considering the 16th and the first half of the 15th centuries BC, the phase belonging to the Minoan Neopalatial Age when the Minoan civilization reached its greatest power – in the political field as well as in the economic and artistic ones. The big *villa* was built on the higher slopes of the hill (Fig. 1)[10]. Some rooms were used as administrative offices and deposits: around 1250 clay objects have been found, and these can be divided in four main typologies: tablets, roundels, *noduli* (sort of tokens with no direct contact with the objects they are related to) and nodules (attached to items of interest either directly or

[10] This and other following images go back to the first excavations of the site by F. Halbherr, reflecting the situation when the objects of our interest were found and sent to the Museum of Florence.

through a string) (Fig. 2). Other places which must have had the same function were found also downtown, in particular in the so-called *Casa del Lebete* (Fig. 3).

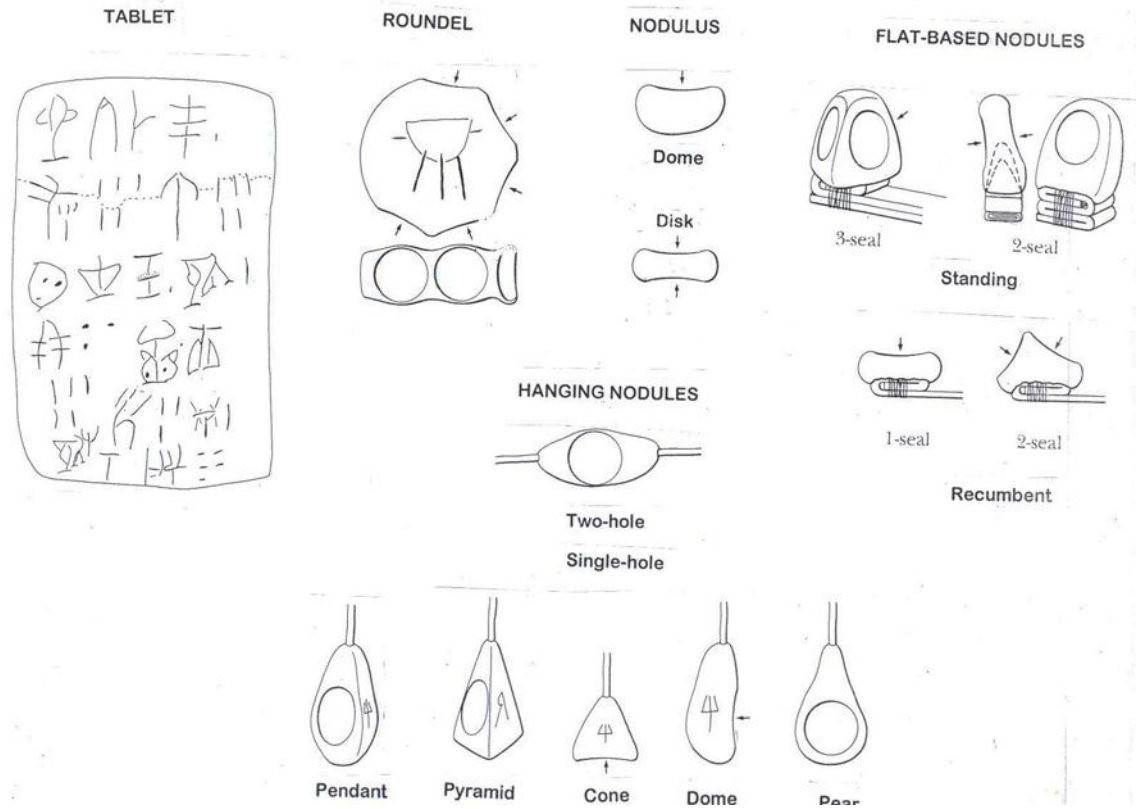


Fig. 2 – The various typologies of administrative documents from Haghia Triada (elaboration from HALLAGER 1996: 23, 32).

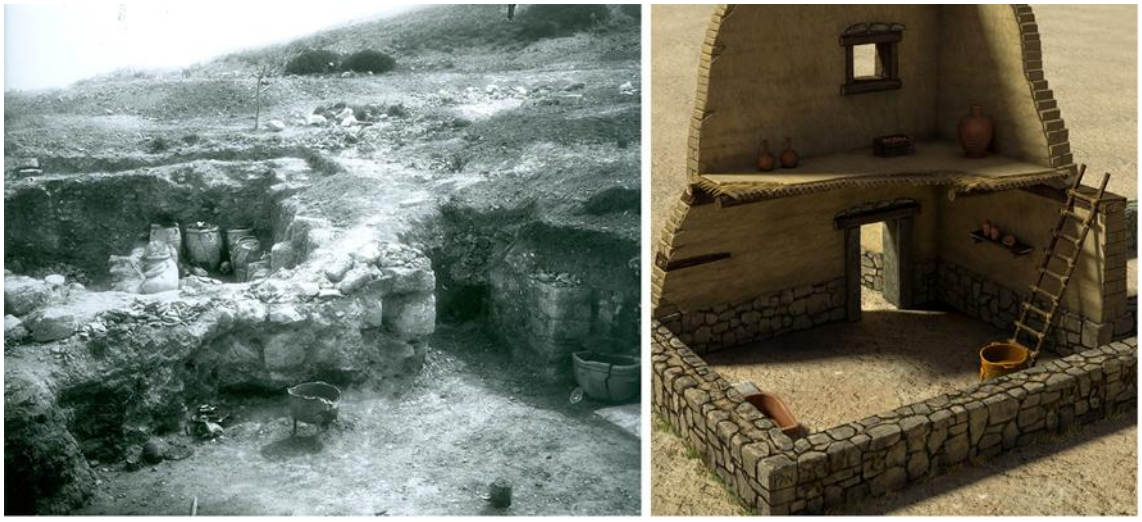


Fig. 3 – *Casa del Lebete*: on the left, photo following the excavation (Photographic material from SAIA – Italian Archaeological School in Athens, kindly offered by the Director, Prof. E. Greco), and on the right, hypothetical reconstruction by P. Kruklidis.

Concerning the palace of Phaistos (Fig. 4), located on another hill overlooking the Messara plain, we will concentrate on a previous phase, characterizing the Protopalatial Age, around the 19th and 18th centuries BC, when various palaces in the island (the best known are those of Knossos, Phaistos and Mallia), ruled

over different areas of Crete. As for the palace of Phaistos we don't have a complete knowledge of the complex for this period, since a second palace was rebuilt over the first – at the same time when also the *villa* of Haghia Triada flourished –, but we had the possibility to recover some parts of the older palace because it was bigger than the new one and because they were separated by a concrete filling. In the open square which extended in front of the western facade of the second palace, the floor just consisted of this stratum of concrete (Fig. 5), which was cut by the excavators and revealed the remains of parts of the first palace with the objects therein, and many other fragments put under the concrete to fill the space between the old and the new palace. During the Protopalatial Age, the period of our interest, the best attested ware is the so-called *Kamares ware*, which derives its name from the first findings in the Kamares cave, on the slopes of Ida mountain, in front of Phaistos.

Fig. 4 – A general view of the ruins of Phaistos palace in a photo following the first excavations and before the removal of the western "filling" (LEVI 1976: Tav. 3/b).

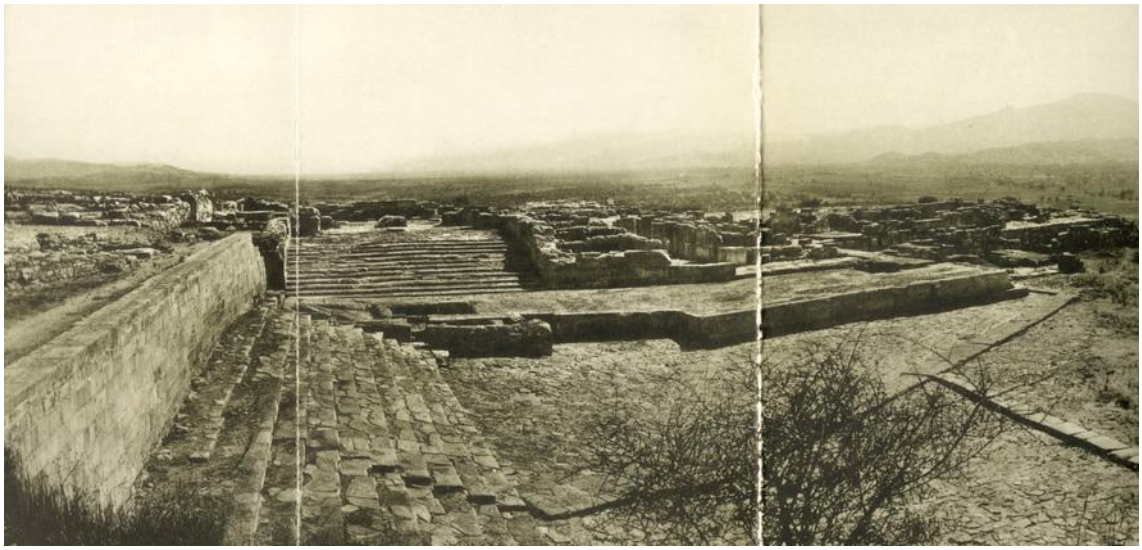


Fig. 5 – View of the ruins of Phaistos from the western facade, with the stratum of concrete covering the First Palace (PERNIER 1935: Tav. IX).

Why are we choosing these particular periods for our paper? Because many examples both of the administrative documents at Haghia Triada and of the *Kamares ware* are actually in the Florentine Museum

and their analysis allows, as we underlined at the beginning of this work, to develop an interactive museum or, better, an itinerary starting from Messara and arriving to Florence.

The excavations of both sites in Messara started at the beginning of the 20th century, undertaken by the Italian Archaeological Mission in Crete, under the direction of Federico Halbherr. The two main Italian figures who promoted the activation of this Mission where Luigi Pigorini and Domenico Comparetti, the first the founder of the Museo Preistorico Etnografico in Rome and the second the founder of the Regio Museo Archeologico of Florence – the present National Archaeological Museum –, which for a long time was directed by Adriano Milani. Their interest to start the archaeological Mission in Crete gave the opportunity to both museums to receive finds directly from the excavators and to create an uninterrupted channel of contacts with the Greek authorities and with Greek art dealers. From here on we will focus on those few objects of which we know the precise original location inside both sites and which were sent to Florence.

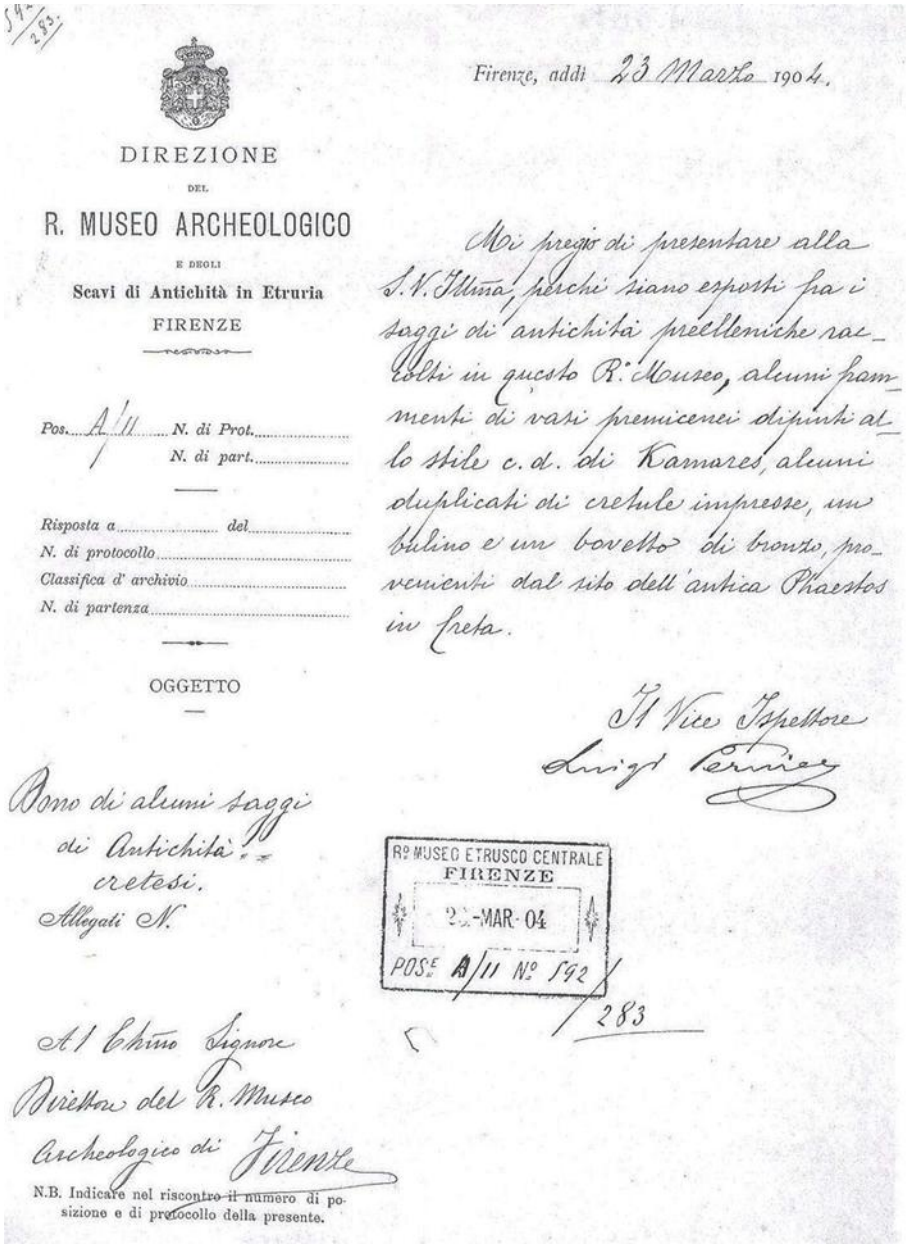
Fig. 6 – Three of the nine nodules of the National Archaeological Museum in Florence from Haghia Triada: in the first row, faces with seal; in the second, faces with incised symbols; and in the third, imprints.

The materials

At Haghia Triada there was, as we stressed above, an extensive administrative activity. In the Florentine Museum only 9 sealings arrived from Haghia Triada – 8 hanging nodules with one hole and 1 with two holes (Fig. 6)[11] –, officially sent with other objects by Luigi Pernier, field director for the Italian Mission, to Milani, as

[11] For a description of the single objects see CR. 225–233 in JASINK and BOMBARDIERI 2009.

we read in a letter of 1904 (Fig. 7). In the other Italian museum, the National Prehistoric Ethnographic Museum “L. Pigorini” in Rome, besides 25 nodules and 5 *noduli* (DEL FREO 2002–2003) also 3 clay tablets are exhibited coming from the same areas as the other small administrative documents (MANGANI 2004: 296). Obviously the greatest number of these objects are located in the Heraklion Museum in Crete. We don’t know where the “scribes” of Haghia Triada actually carried out their activity, but we suppose that it was very close to the rooms where the objects have been found, at least in the same quarters of the villa, where stock rooms, deposits and archives where likely connected.



DIREZIONE
DEL
R. MUSEO ARCHEOLOGICO
E DEGLI
Scavi di Antichità in Etruria
FIRENZE

Pos. A/II N. di Prot.
N. di part.

Risposta a del
N. di protocollo
Classifica d' archivio
N. di partenza

OGGETTO

Firenze, addì 23 Marzo 1904.

Mi pregio di presentare alla S. V. Illma, perchè siano esposti fra i saggi di antichità preelleniche raccolti in questo R. Museo, alcuni frammenti di vasi premicenei dipinti allo stile c. d. di Kamares, alcuni duplicati di cretule impresse, un bulino e un bovetto di bronzo, provenienti dal sito dell'antica Phaestos in Creta.

Il Vice Ispettore
Luigi Pernier

Bono di alcuni saggi di Antichità cretesi.
Allegati N.

R. MUSEO ETRUSCO CENTRALE
FIRENZE
23-MAR-04
POS.E A/II N.° 592
283

Al Chmo Signore
Direttore del R. Museo
Archeologico di Firenze

N.B. Indicare nel riscontro il numero di posizione e di protocollo della presente.

Fig. 7 – Letter written by L. Pernier to A. Milani in 1904 to accompany the finds sent to the Archaeological Museum in Florence (Archivio Storico della Soprintendenza per i Beni Archeologici, Firenze).

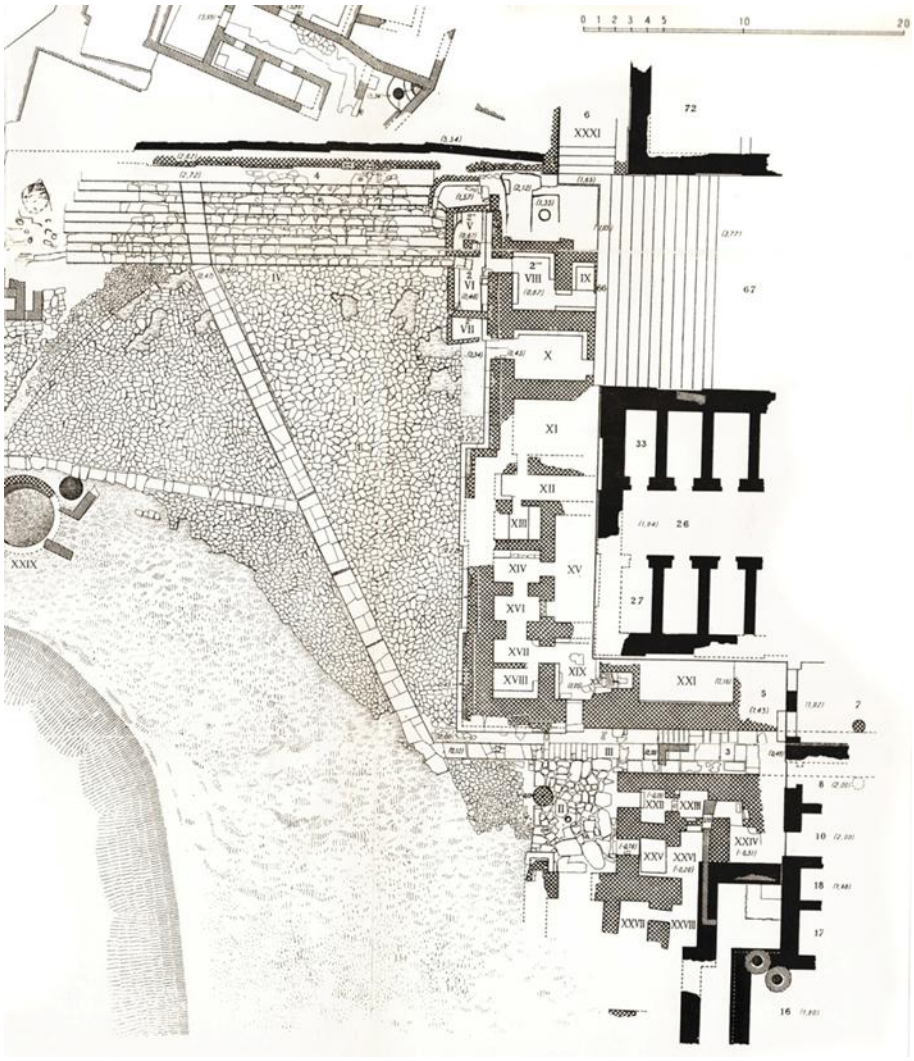


Fig. 8 – Map of the western side of the First Palace of Phaistos (PERNIER 1935: Tav. V).

Concerning the former palace of Phaistos, we have in Florence many exemplars of *Kamares ware*, but only 4 of them have been found in specific locations (Fig. 8). The first two pieces are both *one-handled truncated conical cups*, one (Fig. 9) found generically during the removal of the western “filling” of the first Palace, and the other (Fig. 10) found in the “sacrifical pit” at the basis of the staircase XXXI, where a large quantity of Kamares ware and stone vases, animals’ burned bones, cinders and coal were piled up, all objects meaning the sacral character of the pit, as it may be supposed also from its contiguity to a series of *sacella*. The third object in Florence is a small spouted miniaturistic jug with a crushed globular body (Fig. 11), from Room XVII which is considered one of the small storerooms (X–XVIII) in the western area at the south of the *sacella*. The last piece is a wide-mouthed miniaturistic jar (Fig. 12) from Room XXVII. This room and Room XXVIII are the southern rooms excavated in this section of the palace and their southern wall doesn’t exist anymore.

Fig. 9 – Cup from the western “filling” of the First Palace of Phaistos, CR. 135 (JASINK and BOMBARDIERI 2009).

Fig. 10 – Cup from the “sacrifical pit” of the First Palace of Phaistos, CR. 137 (JASINK and BOMBARDIERI 2009). On the upper right, water-color painting of the same cup by Emilio Stefani, the exceptional drawer of the Italian mission (PERNIER 1935: Tav. XX).

Fig. 11 – Small jug from Room XVII of the First Palace of Phaistos, CR. 146 (JASINK and BOMBARDIERI 2009).

Fig. 12 – Small jar from Room XXVII of the First Palace of Phaistos, CR. 147 (JASINK and BOMBARDIERI 2009).

The virtual itinerary

Among the Aegean artifacts displayed in MUSINT's on-line virtual museum it's possible to examine a selection of the Cretan collections, including also the objects which have been described above *in situ*, that is in their primary location: 4 vases from Phaistos and 9 nodules from Haghia Triada, held by the National Museum in Florence.

The system offers different paths for the visitor to follow: he can start choosing the location of interest from a map of the Aegean Sea and surrounding regions (Greece, Crete, Cycladic islands, Rhodes and Cyprus), and then consult a time-line chart which will give him various kind of historical, geographical and cultural information on the finds produced in a single time span (Fig. 13). Or he can read all data made available and explore images (or 3D models) of the artifacts through their single descriptive sheets (Fig. 14) selecting one of the proposed typologies of manufactured production, symbolized by icons, for a specific region.

Fig. 13 – Selecting region Crete in MUSINT's virtual museum of the Aegean and Cypriot collections in Tuscany.

Fig. 14 – Example of the descriptive sheet of one of the finds which can be digitally explored in 3D.

Another approach to the exploitation of the available documentation is to access galleries of images regarding a distinct location where the finds come from: photos, plans of excavated sites, drawings and renderings. It seemed very useful to present the artifacts in our digital interactive museum combining pictures of the present condition and of the early 20th century, when they were found, with hypothetical reconstructions of the sites, realized through computer graphics, as in (Fig. 15)[12].

Fig. 15 – The *villa* of Haghia Triada in a hypothetical reconstruction by P. Kruklidis.

Younger visitors are invited by the cartoon of a mythological character, as Minotaur in the specific case of Crete, to discover – through his story-telling and suggestions – the contents of the virtual museum in a guided and adapted itinerary.

Three-dimensional models

On a total of 100 finds available in the current digital interactive repository, a selection of about 40 pieces has been digitized in three dimensions for real-time visualization of their present condition, and a few of these are Cretan.

The resulting 3D models allow to explore the objects they represent very faithfully from other viewpoints than the ones permitted by normal and direct non-contact inspection, not to mention the very limited ones offered by photos. And the reviewing at close range allowed by the system's zooming options on the virtual replica may be at a scale larger than real.

The digital copies which can be seen on the on-line application (e.g., see Fig. 16) are based on sets of thousands (or even millions) of points accurately measured on the external surfaces of the objects and on the visible parts of the internal ones. This means that the final 3D models preserve high fidelity to the real objects. Most of the selected artifacts have been surveyed with a triangulation-based laser scanner[13]; a few

[12] On particular techniques for a multimedial reconstruction of archaeological remains in geographical areas see KRUKLIDIS 2011.

[13] NextEngine: <http://www.nextengine.com> (accessed 28/02/2012).

have been digitized with photogrammetric techniques[14], based on the use of a calibrated digital reflex camera, a slide bar and a proprietary algorithm for multifocal image analysis and generation of high-resolution point-clouds where every point is identified by 6 values, the x y z space coordinates and the RGB color ones.

Fig. 16 – Three-dimensional models of a cup, CR. 133, and of a seal, CR. 211 (the two images are not scaled). The first one has been digitized by means of a triangulation-based laser scanner, the second one with micro-photogrammetric techniques.

Fig. 17 – Laser scanning a stirrup jar from Rhodes at the National Archaeological Museum in Florence.

[14] ZScan by Menci Software: <http://www.menci.com/zscan/index.php?lang=en_EN> (accessed 28/02/2012). For the description of the photogrammetric techniques employed for MUSINT refer to MENCI et al. 2011.

The desktop laser scanner we used acquires shape data of the scanned object (recorded in the instrument’s space coordinate system), sweeping its 4 laser stripes across the encountered surfaces (Fig. 17), and also correlated photos through its built-in camera for color textural information of the same parts. The acquisition process is quite short and basically automatic once the setting of parameters (e.g., distance and resolution) and the choice of the right supports and arrangement of the artifact – for every needed view – are done. The object may be resting or standing on a rotating base which turns on predefined steps, connected to the scanner.

The challenge is to cover all surfaces, regarding safety conditions for the artifact and the ideal distance between object and scanner at every different angle, in order to have good quality in the resulting data; but at the same time the goal is to achieve all this with the minimum number of scans, which in a second moment will have to be filtered and combined. At the end of this first phase, several point-clouds of very dense geometric samples on the visible surfaces of the object are created and can be visualized with their related texture.

The collected information is then processed to obtain the digital three-dimensional model, aligning separate scans and then all sequences together, cutting out low quality and redundant data, and fusing all patches in one polygonal mesh. At this point a few small areas may be still missing especially in undercut and narrow hollowed regions (Fig. 18).

Fig. 18 – Model of cup CR. 133 after volumetric fusion, to be used for specific studies on the artifact’s shape and dimensions.

Fig. 19 – The final model of cup CR. 133, to be used for the virtual exhibition: solid view with triangles' edges on the upper right and below (detail), and textured view on the upper left.

For each object we have made available a digital copy for the virtual exhibition and one for scientific examination on request. The two different uses have demanded the definition of separate processing procedures, on the basis of the same acquired data[15]. On one side, we have pushed the elaboration process far beyond mesh fusion, completing an accurate photo-realistic reconstruction of the whole object (Fig. 19), conveniently simplified in order to be easily viewed on the Web application, and edited in its textural appearance to mitigate color and tone variations derived from the source photos and remove reflections given by shiny surfaces. On the other, after merging the selected grid surfaces, we have obtained a highly detailed and precise virtual replica of what of the object the device could capture: this 3D model may be measured without any direct contact on the artifact, guaranteeing sub-millimetric accuracy, and also be used

[15] For a detailed review of all acquisition and processing stages and of problematic issues see TUCCI, CINI, NOBILE 2012.

to extract sections, in order to show e.g. the ceramic vessel's morphological irregularities and thickness where the internal parts have been acquired by the instrument.

As a consequence of our testing different procedures on different shapes and materials, we optimized a methodology and prepared a clear exposition of technical guidelines to be followed easily also by non-specialized digital information providers and in other similar Cultural Heritage applications[16].

Archaeometric analyses

An archaeometric study of the *Kamares* wares in Florence has been carried out, and particularly of the two above mentioned cups from Phaistos, the one from the "western filling" and the other from the "sacrifical pit". They have been analyzed with micro-Raman spectroscopy and with SEM microscopy: this is the first time that these types of archaeometric analyses are applied to this Minoan ware. We show here an example of the detailed information of the object and the results collected in the final tables after the analyses (Fig. 20).

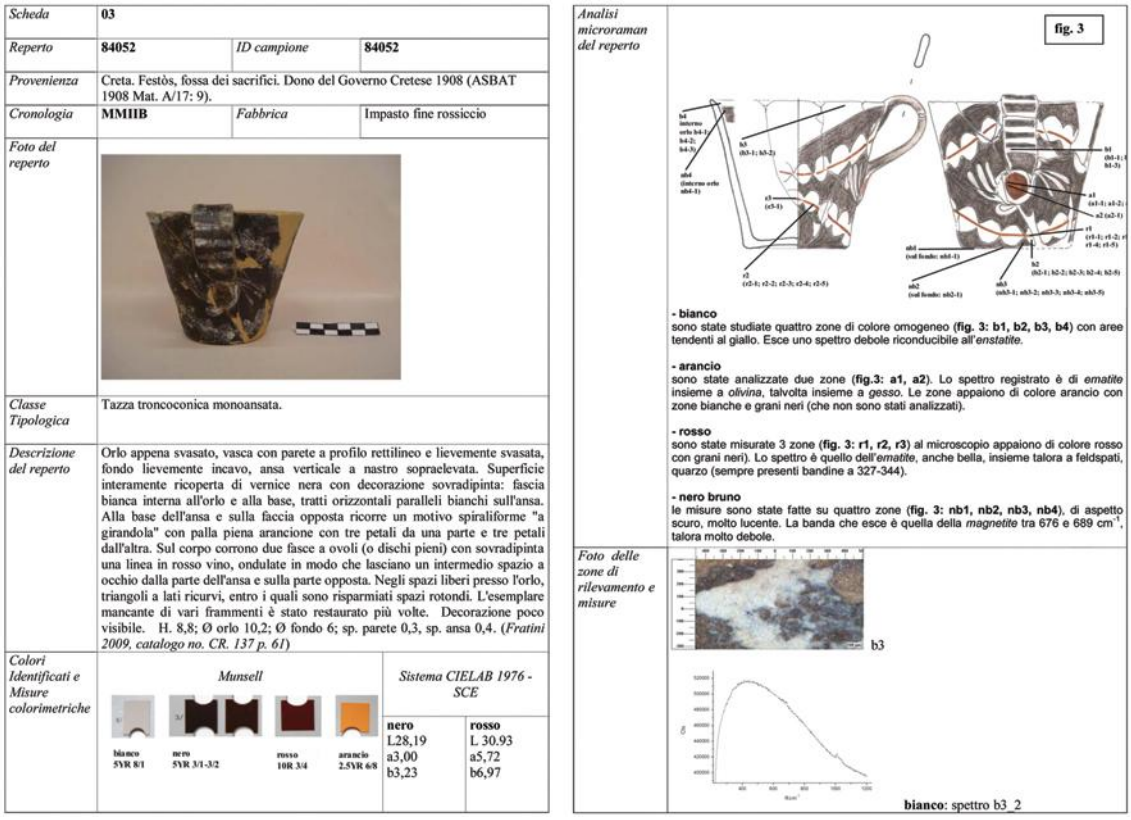


Fig. 20 – Partial example of data collected after the archaeometric analyses on cup CR. 137 (T. Fratini, PhD Thesis, University of Florence 2012).

Conclusions

As this paper has shown giving an account of a representative part of a Cretan collection held by Italian museums and virtually included in a digital and on-line explorable display, the MUSINT project has been

[16] See our contribution in TUCCI, CINI, BONORA, NOBILE 2011.

intrinsically multidisciplinary, requiring the convergence of several areas of expertise as archaeology, history, multimedial communication, three-dimensional survey and modeling, free-hand drawing and computer graphics, archaeometry.

The integration in this structured informative and educational system of a large number of accurate and reliable 3D digital models, and of substantial descriptive textual, cartographic and photographic documentation, recreates the historical context for each finding.

Interaction on the Web, and probably in the next future also on stand-alone interfaces situated in the actual physical museum spaces in Italy, will be a fundamental teaching aid to make users understand and access the reconstructed provenance environment and relocate culturally and physically distant findings where they once belonged.

In this way it will also be possible to recover the urban, social, political and economic environment of Bronze Age settlements in all areas of interest (Greece, Crete, Cycladic islands, Rhodes and Cyprus).

References

DEL FREO, M. (2002–2003). “Le cretule di Haghia Triada nel Museo Nazionale Preistorico Etnografico ≪Luigi Pigorini≫. Catalogo”, *Bullettino di Paleontologia Italiana*, n.s. 11–12: 53–75.

HALLAGER, E. (1996). *The Minoan Roundel and Other Sealed Documents in the Neopalatial Linear A Administration*. I–II vol. Aegaeum 14. Liège.

JASINK, A. M. and BOMBARDIERI, L. (eds.) (2009). *Le collezioni egee del Museo Archeologico Nazionale di Firenze.* Florence, Italy: Firenze University Press.

JASINK, A. M., TUCCI, G. and BOMBARDIERI, L. (eds.) (2011). *MUSINT. Le Collezioni archeologiche egee e cipriote in Toscana. Ricerche ed esperienze di museologia interattiva*. Florence, Italy: Firenze University Press.

KRUKLIDIS, P. (2011). “L’epopea omerica. Tecniche di ricostruzione multimediale”, in: JASINK et al. 2011: 125–135.

LEVI, D. (1976). *Festòs e la Civiltà Minoica*. Rome, Italy.

MANGANI, E. (2004). “La formazione della Collezione Cretese del Museo Nazionale Preistorico Etnografico di Roma”, *Bullettino di Paleontologia Italiana*, 95, n.s. 13: 279–348.

MENCI, L., CECCARONI, F. and BIANCHINI, D. (2011). “Un metodo alternativo di digitalizzazione: Z-Scan”, in: JASINK et al. 2011: 101–104.

NUNZIATI, W., CANALICCHIO, R. and BENCINI, M. (2011). “Il sito Web del progetto MUSINT”, in: JASINK et al. 2011: 115–124.

PERNIER, L. (1935). *Il palazzo Minoico di Festos, I, Scavi e studi della missione archeologica italiana a Creta dal 1900 al 1934*. Rome, Italy.

TUCCI, G., CINI, D., BONORA, V. and NOBILE, A. (2011). “Proposta metodologica per la digitalizzazione 3D di reperti archeologici”, in: JASINK et al. 2011: 65–100.

TUCCI, G., CINI, D. and NOBILE, A. (Forthcoming 2012). “A Defined Process to Digitally Reproduce in 3D a Wide Set of Archaeological Artifacts for Virtual Investigation and Display”, *Journal of Earth Science and Engineering*, 2 (2), David Publishing Company, ISSN 2159-581X.